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Seeing More Than We Can Know: Visual Attention and Category Activation

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Extending existing work on the conditional automaticity of category activation, the present research investigated the extent to which category activation is moderated by the resolution of visual attention. As visual attention gates access to material in semantic memory, so too should it regulate the activation of social categories when triggering verbal labels are encountered. Accordingly, only when triggering stimuli fall within the spotlight of attention did we expect category activation to occur. The results of two studies supported this prediction. We consider the implications of our findings for recent treatments of category automaticity. © 1999 Academic Press

In attempting to make sense of the surrounding stimulus world, perceivers regularly construct and use categorical representations to simplify and structure

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the complex demands of the person-perception process. A debate that has dominated recent theorizing about the nature and function of these representations concerns the conditions under which social categories and their associated stereotypes are activated by perceivers in their dealings with others (see Bargh, 1999; Bodenhausen & Macrae, 1998; Fiske, 1989). Put simply, is category activation an unconditionally automatic mental process or can it be avoided under certain circumstances?

While several theorists have argued for the inevitability of category (hence stereotype) activation (e.g., Allport, 1954; Bargh, 1999; Brewer, 1988; Devine, 1989; Dovidio, Evans, & Tyler, 1986; Fiske & Neuberg, 1990), recent research has identified some important constraints on this process (e.g., Blair & Banaji, 1996; Gilbert & Hixon, 1991; Lepore & Brown, 1997; Macrae, Bodenhausen, Milne, Thorn, & Castelli, 1997). Gilbert and Hixon (1991), for example, have demonstrated that stereotype activation can be impeded under conditions of attentional depletion (see also Spencer, Fein, Wolfe, Fong, & Dunn, 1998). In a similar vein, perceivers' temporary goal states also appear to play a pivotal role in the regulation of category activation. In particular, activation does not occur when the social meaning of a target is irrelevant to perceivers' current information-processing concerns (Macrae et al., 1997). Finally, people's beliefs about the members of stigmatized groups also impact upon the activation of schematic knowledge structures. An emerging literature has confirmed that, unlike their prejudiced counterparts, egalitarian individuals are able to avoid stereotype activation when presented with a triggering categorical cue (Fazio, Jackson, Dunton, & Williams, 1995; Lepore & Brown, 1997; Locke, MacLeod, & Walker, 1994; Wittenbrink, Judd, & Park, 1997). Thus, it seems that category activation is not unconditionally automatic or inevitable (cf. Bargh, 1999); instead, it appears to be responsive to perceivers' attentional limitations, temporary goal states, and chronic beliefs.

Noting the obvious theoretical importance of work of this kind, the present studies were motivated by a desire to expand our knowledge of the conditions governing category activation. Of particular interest was the question of whether perceivers can successfully avoid category activation when spatial visual attention is focused away from a triggering categorical cue that is present in the visual field. Consider, for example, the phenomenon of parafoveal priming. It is well known that stimuli presented away from the locus of focal attention (i.e., stimuli that register on retinal regions outside the fovea) are capable of producing semantic activation, even though the perceiver may have no conscious awareness of the stimuli (e.g., Fuentes, Carmona, Agis, & Catena, 1994; Fuentes & Ortells, 1993). For instance, Fuentes and Ortells found that performance on a Stroop task was influenced by stimuli presented parafoveally. This phenomenon produces several adaptive advantages for perceivers, such as the parafoveal preview benefit in reading (e.g., Everatt & Underwood, 1992; Kennison & Clifton, 1995). Preconscious processing of upcoming words (i.e., before they have received a foveal fixation) guides eye movements in a manner that focuses conscious attention on the most meaningful and informative aspects of lexical stimuli. For this ‘‘preview’’ screening to occur, of course, the stimuli must have been processed in some fashion prior to perceivers’ conscious awareness of them.

But can the semantic activation elicited by parafoveally presented stimuli be avoided? If social perceivers are consciously focusing their attention at one location, can they avoid activating a category that is cued by a stimulus that is present at another location? Recent research would suggest that indeed they can, with both perceivers’ processing goals and the perceptual demands of the task at hand moderating construct activation (LaBerge, Brown, Carter, Bash, & Hartley, 1991; Lavie, 1995; Ortells & Tudela, 1996). But would the same be true for social categories, stimuli which have been characterized by some as being so over-learned that their activation is simply inevitable (Allport, 1954; Bargh, 1999; Devine, 1989)? If perceivers are indeed unable to avoid category activation even when the triggering stimulus lies outside the focus of their focal attention, then models asserting the inevitability of category activation would gain considerable support (Brewer, 1988; Devine, 1989; Fiske & Neuberg, 1990). However, it may be more likely that perceivers are indeed able to avoid category activation when triggering stimuli are presented outside focal attention (Lavie, 1995), if such activation serves no useful purpose in attaining their immediate processing objectives (Macrae et al., 1997).

THE SPOTLIGHT OF ATTENTION

But how can we focus our attention on some things while simultaneously ignoring others? According to James (1890), the answer is simple; selective attention can be likened to a spotlight, with objects that fall within its beam enjoying privileged processing. As Broadbent (1982) has argued, ‘‘think of selectivity as like a searchlight, with the option of altering the focus. When it is unclear where the beam should go, it is kept wide. When something seems to be happening, or a cue indicates one location rather than another, the beam sharpens and moves to the point of maximum importance’’ (p. 271). To identify the resolution of visual attention, researchers have traditionally employed visual search tasks of one sort or another. One particular favorite is the flanker task, a modified version of which will be used in the present work. Devised over 20 years ago by Eriksen and his colleagues (see Eriksen, 1995), the flanker task utilizes response competition to measure the extent to which unattended stimuli are processed by perceivers.

In the original version of the flanker task, Eriksen and Eriksen (1974) varied the distance between a central letter and neighboring items (i.e., flanker letters) that appeared on the left and right of the target. Participants were shown a target letter from one of two sets (i.e., C and S or H and K) and instructed to move a lever to the left or right depending upon the stimulus–response mapping they had been given (e.g., if C or S move the lever to the left; if H or K move the lever to the right). Simultaneously, irrelevant flanking letters also appeared on the screen and, critically, sometimes these letters were drawn from the aforementioned target sets.

Of particular interest were participants' response times on displays when the flanking items were assigned to a different response class than the target letter (e.g., C flanked by K's). If response times to the target letters were impaired under these conditions, then this would indicate that participants had processed and extracted the meaning of the unattended (i.e., irrelevant) flanking stimuli. Importantly, while flanker interference was observed in this research, the results revealed that the amount of interference was a function of the degree of physical separation between the attended and unattended stimuli, with near flankers prompting greater interference.[1] As Eriksen has since noted, "there is a gradient around the spatial location of the attended target and only distracters within about 1.5° of the target elicit response competition" (1995, p. 111).

Extrapolating from this kind of finding, in the present work we sought to examine whether the presentation of social category labels (a more semantically rich and arguably more potent potential distracter) would also produce flanker interference effects. More important, we wanted to determine whether such effects are limited to cases in which the labels are presented within the spotlight of attention or whether the effect might generalize to stimuli that engage only peripheral attentional mechanisms. If social categories are so strongly overlearned that their activation is inevitable upon registration of a relevant cue (Devine, 1989), then even spatially distant category cues may produce flanker interference. However, if perceivers are indeed able to focus their attentional "spotlight" effectively on the target stimulus, then category cues outside the spotlight of attention may have little effect on task performance.

EXPERIMENT 1

Method

Participants and design. Eighteen undergraduates (9 women and 9 men) were paid £2 for their participation in the experiment. The experiment had a 2 (flanker status: mismatching or control) $\times$ 2 (flanker location: near or far) repeated-measures design.

Stimulus materials and procedure. Participants arrived at the laboratory individually, were greeted by a male experimenter, and seated facing the screen of an Apple Macintosh microcomputer (Power Mac 7500/100). The experimenter then explained that the study was a gender-categorization task. In the center of the computer screen, a number of forenames would appear (e.g., *peter, clare*). The task was simply to report, by means of a key press, whether each forename was characteristically male or female. The experimenter instructed each participant to perform this task as quickly and accurately as possible. In total, 60 forenames appeared on the screen, 30 of which were male names (e.g., *ian, john, david*) and 30 of which were female names (e.g., *ann, mary, susan*). The forenames were all

[1] Under certain conditions, spatially distant flankers have been shown to produce significant interference effects (Lavie, 1995; Miller, 1991). This demonstration is important as it confirms that limitations in visual attention rather than visual acuity moderate the elicitation of construct interference.

written in lower case letters. Prior to starting the task, the experimenter furnished an additional instruction to each participant. Specifically, he told the participant that on each trial an additional item would appear on the screen. It was stressed, however, that these additional items were irrelevant to the task and should be ignored. In reality, of course, these items comprised the critical flanking stimuli (see Eriksen, 1995). During the task, each forename (e.g., *peter*) was paired once with the name of a common object (e.g., *kettle*, *chair*, *table*) and once with a gender-mismatching forename (e.g., *angela*), giving a total of 120 trials. Across the stimulus presentations, there were therefore two classes of experimental trial: mismatches occurred when the gender of the two forenames was inconsistent; control trials occurred when the forenames were paired with common objects.[2] Thus, relative to performance in the control condition, the mismatching condition enabled us to investigate the extent to which participants processed the categorical meaning of the unattended stimuli. If these flankers were processed categorically, response times to the target items should be impaired (see Macrae, Bodenhausen, Milne, Castelli, Schloerscheidt, & Greco, 1998).

The stimuli were presented on an Apple 17-in. monitor, set to a resolution of 640×480 pixels with a refresh rate of 67 Hz. During the experiment, the computer screen was painted white. Participants were seated 57 cm from the screen and were instructed to fixate on a small black cross (i.e., fixation cross) that was located in the center of the screen. To maintain a fixed viewing distance, each participant's chin was placed in a support (i.e., chin rest) for the duration of the experiment. Stimuli were drawn in an off-screen buffer and were copied onto the screen in synchrony with the computer's vertical blank signal. On each trial, the flanking stimulus appeared unpredictably either above or below the forename. Across all the trials, the flankers appeared an equal number of times above and below the forenames.

The experimenter explained that the target forenames would always be located on the fixation cross. On each trial, the fixation cross appeared for 1000 ms, then a forename and a flanking stimulus appeared simultaneously on the screen. The forename remained on the screen for 2000 ms or until the participant responded. The flanking stimulus was presented for 184 ms, then erased. The interstimulus interval was 1000 ms. The forenames and flanking stimuli were black and were drawn in Apple's Geneva font. The forenames were centered both horizontally and vertically on the fixation cross (which was erased immediately before the forename appeared). The flankers were also horizontally centered on the screen. However, they were positioned either above or below the forename at one of two locations such that the topmost pixels of an upper flanker were either 0.7° or 1.7° of visual angle above the fixation cross and the bottommost pixels of a lower

[2] In the present experiment, we did not include a condition where target items were flanked by gender-matching forenames. Elsewhere, also in the context of a gender-categorization task, it has been shown that matching flankers do not facilitate task performance (Macrae et al., 1998). Given the ease with which gender can be inferred from a presented forename, it may be impossible to improve task performance through the provision of gender-matching flankers.

flanker were either 0.7° or 1.7° of visual angle below the fixation cross. These stimulus configurations created the near and far flanker conditions (Eriksen, 1995). Presentation of the stimuli was randomized for each participant by computer software and participants made their responses by pressing one of two labeled keys (i.e., ‘‘male’’ or ‘‘female’’). The meaning of the response keys was counterbalanced across the experiment and the computer recorded the latency and accuracy of each response. Upon completion of the task, participants were debriefed, paid, thanked for their participation, and dismissed.

Results and Discussion

The dependent measure of interest in this experiment was the mean time taken by participants to categorize the forenames by gender. All trials where participants categorized the forenames incorrectly (5.3% of trials) were excluded from the statistical analysis. Error rates in the near and far flanker conditions were equivalent (respective *M*s: 5.4% vs 5.1%). Because of an unduly high error rate (14%), one participant was excluded from the statistical analysis. Prior to the analysis, a log transformation was performed on the data. For ease of interpretation, however, the untransformed means are reported in Table 1.

Preliminary analysis revealed no effect of the gender of participants on task performance, consequently the data were collapsed across this factor. Participants’ categorization times were submitted to a 2 (flanker status: mismatching or control) $\times$ 2 (flanker location: near or far) repeated-measures analysis of variance (ANOVA). This analysis revealed main effects of flanker status [$F(1, 16) = 10.69$, $p < .005$] and flanker location [$F(1, 16) = 28.60$, $p < .0001$] on participants’ categorization times. As expected, however, these effects were modified by a significant flanker status $\times$ flanker location interaction, $F(1, 16) = 5.36$, $p < .04$ (see Table 1 for treatment means). Simple effects analysis confirmed that categorization times were slower on mismatching than control trials in the near flanker condition, $F(1, 16) = 12.57$, $p < .003$. Importantly, no such difference emerged in the far flanker condition, $F(1, 16) = 1.16$, *ns*. In addition, categorization times were slower in the near than far flanker condition on both mismatching [$F(1, 16) = 28.16$, $p < .0001$] and control [$F(1, 16) = 11.01$, $p < .004$] trials.

TABLE 1
Mean Categorization Times (in Milliseconds) as a Function of Flanker Status and Location (Experiment 1)

Flanker status	Flanker location	
	Near	Far
Control	642 (74)	612 (80)
Mismatching	676 (79)	620 (82)
Interference	*34*	*8*

Note. Standard deviations in parentheses.

These results confirm that activation of social categories based on parafoveal cues did not occur. Only when mismatching flankers fell within the spotlight of attention did they impair performance on the gender-categorization task. When the flankers engaged peripheral attentional mechanisms, category interference was not observed (Eriksen, 1995; Eriksen & Eriksen, 1974). Extending previous research, then, these findings reveal another factor upon which category activation would appear to be conditional—namely, the resolution of visual attention. There are, however, some limitations with Experiment 1 that merit consideration. The finding of theoretical interest was that far flankers did not impede performance on the gender-categorization task, thereby suggesting that these items fell outside the spotlight of attention (Eriksen, 1995). Of course, a quite different explanation can also be offered for the failure of construct interference to emerge in this condition—perhaps the far flankers were never processed at all. While such an outcome is unlikely given previous work on this topic (see Eriksen, 1995; Lavie, 1995; Miller, 1991), in the present experimental context it is not possible to refute this competing explanation without additional evidence.

The motivation for our second experiment, therefore, was quite straightforward. Specifically, we sought to demonstrate that while distant flankers do not activate categorical representations and hence do not impede performance on the gender-categorization task, they are nevertheless processed by perceivers. To investigate this issue, we made a simple modification to our original experimental procedure. Following the gender-categorization task, participants were given an ostensibly separate experiment in which they were required to report whether a stimulus (e.g., *kettle* or *susan*) referred to the name of an object or the name of a person (i.e., an item-classification task). Of the presented forenames, half were items that had previously appeared as flankers (near and far) in the gender-categorization task, whereas the other forenames were entirely new items. Our logic was as follows. For items that were presented (i.e., processed) before, one would expect to observe facilitated responding in the item-classification task, as these stimuli have recently been actively represented in memory (see Roediger & McDermott, 1993; Schacter, 1987). The question of interest concerns whether this is true of both near and far flankers. If far flankers are indeed processed by perceivers in the initial gender-categorization task, then these stimuli should enjoy a classification advantage (relative to new forenames) when they are reencountered on the second task (Scarborough, Gerard, & Cortese, 1979).

EXPERIMENT 2

Method

Participants and design. Twelve female undergraduates were paid £2 for their participation in the experiment. The experiment had a 2 (flanker status: mismatching or matching) × 2 (flanker location: near or far) repeated-measures design.

Stimulus materials and procedure. Participants arrived at the laboratory individually, were greeted by a male experimenter and seated facing the screen of an Apple Macintosh microcomputer (PowerPC G3). This experiment was basically a replication of Experiment 1, but with several important modifications. To provide a new control condition against which construct interference could be established, the object/control trials were replaced with gender-matching trials (see Eriksen, 1995; Macrae et al., 1998). These trials were created by pairing gender-matching flankers with the target forenames. In total, 40 forenames appeared on the screen; 20 of which were male names and 20 of which were female names. During the task, each target item was paired once with a gender-mismatching forename (i.e., mismatching trials) and once with a gender-matching forename (i.e., matching trials), giving a total of 80 trials. In all other respects, the procedure was identical to Experiment 1.

Upon completion of the gender-categorization task, the experimenter instructed each participant that she would be required to perform another response-time task. On this occasion, either the name of a person (e.g., *mark*) or the name of an object (e.g., *knife*) appeared in the center of the computer screen. The task was simply to report, by means of a key press (as quickly and accurately as possible), the identity of the stimulus (i.e., person name or object name?). In total, 64 items appeared in the test (32 forenames and 32 objects). Of the 32 forenames, 16 were items that had previously appeared as flankers (8 near and 8 far) in the gender-categorization task, the other 16 were entirely new forenames. Each item remained on the screen until the participant made a response. Presentation of the stimuli was randomized for each participant by computer software and participants made their responses by pressing one of two labeled keys (i.e., ‘‘person’’ or ‘‘object’’). The meaning of the response keys was counterbalanced across the experiment and the computer recorded the accuracy and latency of each response. Upon completion of the task, participants were debriefed, paid, thanked for their participation, and dismissed.

Results and Discussion

Gender-categorization task. The dependent measure of interest was the mean time taken by participants to categorize the forenames by gender. All trials where participants categorized the items incorrectly (4.1% of trials) were excluded from the statistical analysis. Error rates in the near and far flanker conditions were equivalent (respective *M*s: 4.5% vs 3.7%). Prior to the statistical analysis, a log transformation was performed on the data. For ease of interpretation, however, the untransformed means are reported in Table 2.

Participants’ categorization times were submitted to a 2 (flanker status: matching or mismatching) $\times$ 2 (flanker location: near or far) repeated-measures ANOVA. This revealed a main effect of flanker status [$F(1, 11) = 5.13$, $p < .05$] and a marginal effect of flanker location [$F(1, 11) = 3.86$, $p < .08$] on participants’ categorization times. As expected, however, these effects were modified by a significant flanker status $\times$ flanker location interaction, $F(1, 11) = 16.44$, $p < .002$ (see Table 2 for treatment means). Simple effects analysis confirmed that categorization times were slower on mismatching than matching trials in the near flanker condition, $F(1, 11) = 16.63$, $p < .002$. Importantly, no comparable effect

TABLE 2
Mean Categorization Times (in Milliseconds) as a Function of Flanker Status and Location (Experiment 2)

Flanker status	Flanker location: Near	Far
Matching	645 (92)	652 (81)
Mismatching	730 (103)	639 (71)
Interference	*85*	*−13*

Note. Standard deviations in parentheses.

emerged in the far flanker condition, $F(1, 11) < 1$, *ns*. In addition, categorization times were slower in the near than far flanker condition on mismatching trials, $F(1, 11) = 18.32$, $p < .001$. Extending Experiment 1, then, these findings confirmed the effects of flanker location on category activation. They did so, however, under conditions in which all the stimuli (i.e., flankers) were relevant to the task of gender categorization. In Experiment 1, the control items were the names of common objects, items that are irrelevant with respect to gender classification (at least in the English language). In the present experiment, in contrast, gender-matching flankers were employed in the control condition (Macrae et al., 1998), thus all the flankers were equated in terms of the extent to which they conveyed gender information. As before (i.e., Experiment 1), category activation only emerged in the near flanker condition.

Item-classification task. The dependent measure of interest was time taken by participants to classify the forenames. There were no errors on this task. Prior to the statistical analysis, a log transformation was performed on the data. For ease of interpretation, however, the untransformed means are reported. Participants' classification times were submitted to a single factor (item type: old-near or old-far or new) repeated-measures ANOVA. This revealed an effect of item type on participants' classification times, $F(2, 11) = 7.52$, $p < .004$. Post hoc Tukey tests confirmed that participants offered faster responses both to old-near ($M = 568$ ms) and old-far ($M = 561$ ms) items than they did to entirely new forenames ($M = 619$ ms, both $ps < .01$). In other words, in the classification task there was an advantage for old forenames, regardless of their previous flanker location (Roediger & McDermott, 1993). Taken together, then, these findings confirm that participants do indeed process the distant flankers. As these items fall outside the spotlight of attention, however, they do not produce category activation and hence do not give rise to flanker interference (Eriksen, 1995).

GENERAL DISCUSSION

We hypothesized that the resolution of visual attention may be a fundamental determinant of category activation. The theoretical basis of our prediction was an extensive literature in cognitive psychology documenting how visual attention gates access to material in semantic memory (e.g., Driver & Bayliss, 1989; Eriksen, 1995; LaBerge et al., 1991). In line with this literature, we postulated that the resolution of visual attention should moderate the activation of social categories when perceivers are presented with triggering verbal labels. At first blush, this line of inquiry may appear somewhat removed from the topic of person perception. In reality, however, it is well suited to an investigation of the determinants of category activation. Inspection of the existing literature reveals that much of the evidence for the automaticity of category activation has been collected in studies that employ semantic priming procedures and verbal stimulus materials (e.g., Devine, 1989; Dovidio et al., 1986; Perdue & Gurtman, 1990). If categorical priming effects can be eliminated under these same conditions, this would seriously undermine the assumption that category activation is inevitable, a viewpoint that has dominated thinking in social psychology for almost half a century (Allport, 1954).

Confirming our reasoning, category activation was indeed moderated by the resolution of visual attention. Only when triggering stimuli (i.e., forenames) fell within the spotlight of attention (i.e., within about 1° of visual angle) did perceivers proceed to activate associated categorical representations. This finding is noteworthy for a number of reasons. Previous research on this topic has tacitly assumed that the mere registration of a verbal label is sufficient to prompt category activation—indeed, claims of category automaticity rest upon the veracity of this supposition (see Devine, 1989; Dovidio et al., 1986; Macrae, Milne, & Bodenhausen, 1994; Perdue & Gurtman, 1990). As it turns out, however, when triggering stimuli fall outside the beam of the attentional spotlight, category activation does not occur.

Notwithstanding the potential theoretical significance of this finding, some puzzling issues remain. In particular, given our contention that category activation is moderated by the resolution of visual attention, why is it that a handful of studies have demonstrated category activation without seemingly satisfying this criterion? To date, some of the most compelling evidence for category automaticity has been gathered in studies that have used parafoveal priming techniques to present participants with triggering verbal labels (e.g., Devine, 1989; Lepore & Brown, 1997; Macrae, Bodenhausen, & Milne, 1995). Although these parafoveal stimuli (e.g., category labels) ostensibly fall outside the spotlight of attention, they nevertheless prompt category activation. Given the present results, how can this be?

The resolution of this puzzle, we suspect, may reside in the perceptual demands of parafoveal priming tasks. In a typical category-priming experiment (e.g., Devine, 1989; Lepore & Brown, 1997), while fixating on a central cross, participants are required to report the location of multiple flashes that appear at different locations on the screen. Two points are worthy of mention here. First, the central cross is perceptually redundant, as responses are not required to items at fixation. Second, successful task performance demands the rapid detection of spatially distinct perceptual events. These task characteristics, we believe, may ultimately promote category activation. One possibility, for example, is that participants may periodically avert their gaze from the fixation cross, hence detect the identity of the priming stimuli on some trials. The large number of priming trials and the relatively long exposure duration (e.g., 100 ms) of the priming stimuli may serve to encourage just this sort of effect. Alternatively, as no response is required to items at fixation, this may prompt a widening of the attentional spotlight (see Broadbent, 1982; Lavie, 1995), hence a semantic appraisal of the priming labels (Devine, 1989; Lepore & Brown, 1997). This widening of focal attention does not occur in the present flanking procedure, however, as participants are required to respond to items that appear at fixation (Lavie, 1995). Thus, procedural differences between parafoveal priming and flanker tasks may account for apparent discrepancies between the present findings and some previous research on the topic of category activation.

CONCLUSIONS

Our intention in the present article was to demonstrate how basic limitations in the resolution of visual attention may moderate the process of category activation. We were generally successful in this regard. Only when triggering verbal labels fell within the spotlight of attention did category activation occur, thereby confirming the conditional automaticity of this process (Gilbert & Hixon, 1991; Macrae et al., 1997). Of course, were mental life to unfold in any other way, it is difficult to imagine how social perceivers could begin to make sense of others. The limits of visual attention ensure that irrelevant perceptions or sensations rarely overwhelm us (Broadbent, 1982; James, 1890). If all unattended visual stimuli (including people) were afforded a complete semantic analysis, life as we know it would grind to a shuddering halt. That psychological paralysis is avoided so effortlessly is testimony to the power of selective attention—through its silent workings, selective attention inoculates the mind from the specter of cognitive debilitation. Social cognition, of course, is no exception to this rule. Where people are concerned, we may frequently see more than we can know.

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